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Visualization of r-f magneto-acoustic wave of $FeBO_3$ single crystal by using stroboscopic X-ray topography

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Introduction

The antiferromagnet iron borate ($FeBO_3$) single crystal (T_N=348.5K) has a calcite structure and it shows a good transparency in the visible region of the spectrum. This crystal has some unique magneto-elastic properties and they hold promise for the observation of nonlinear effects [1-3], and even magneto acoustic solitons [4]. Therefore, the investigation on the magneto-acoustic vibration of $FeBO_3$ single crystal is very interesting. Recently, in order to visualizing this magneto-acoustic vibration phenomenon, we carried out stroboscopic double crystal x-ray topography experiment by using single bunch mode of SR. Here, the acoustic vibration of $FeBO_3$ crystal was excited by a comparatively low frequency (794KHz) r-f magnetic field, which was synchronized with SR X-ray pulse.

Experimental

The experiment was performed at NE3 undulator beam line of KEK. As is shown in Fig.1, the synchrotron beam was tuned to λ=0.86Å by C(111) double crystal monochromator, and was collimated by Si(331) asymmetric reflection (1/b=6.3,ω_h=0.44arcs). Then, the delivered X-ray beam becomes parallel in comparison with the diffraction width of $FeBO_3$(444) Bragg reflection. The distance between Si(331) and $FeBO_3$(444) was close to each other, which fulfilled a condition of (+-) parallel setting. An external r-f magnetic field was applied parallel to $FeBO_3$(111) plane and perpendicular to scattering plane with peak amplitude of 15Oe and frequency of 794KHz. The frequency was same frequency of SR X-ray pulse exactly. In phase locking, the timing of SR X-ray incidence was fixed in the phase of zero amplitude of r-f magnetic field.

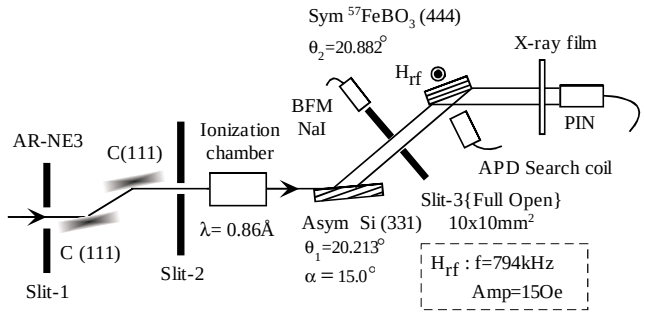

Fig.1. Optics for stroboscopic X-ray topography.

Results

Stroboscopic X-ray topography was recorded at the peak position of rocking curve. Typical rocking curve and topography are shown in Fig.2. The recorded topograph shows the contrast of a periodic black-and-white stripe pattern clearly. The distance between the nodes of magneto acoustic standing wave was estimated at about 1.0mm. This result implies that 'low frequency (794KHz)' r-f magnetic field of 15Oe excites the acoustic standing wave in $FeBO_3$ crystal resonantly, and it causes a striped deformation for $FeBO_3$ crystal through magnetostrictive interaction. From the distortion pattern, we can understand the vibration mode is a membrane-type.

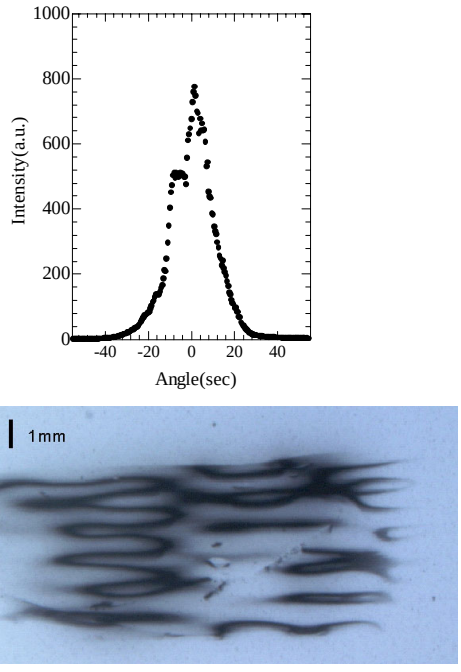

Fig.2. Rocking curve and stroboscopic topograph of $FeBO_3$(444) reflection placed in r-f magnetic field. Topograph is recorded at peak angle of rocking curve.

References

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